Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1, No.15 : 2024
ISSN : **1906-9685**

AN EXPERIMENTAL STUDY ON REPLACEMENT OF CEMENT WITH METAKAOLIN AND MARBLE WASTE POWDER IN CONCRETE

[1]P MOHAMMED MUDASSIR,[2]B FAYAZ
[1]Student,[2]Assistant Professor
Department Of Civil Engineering
PVKKIT,Anantapur

ABSTRACT
In construction Industry, consumption of cement is increasing day by day as well as cost is also increasing so to reduce the consumption of cement, partial replacement with Metakaolin and Marble powder was done in this study. Metakaolin is a calcinied clay and easily available in Gujarat, Maharashtra & Bombay etc. It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain i.e. ceramic material. `The aim of the present study is to use naturally available and low cost metakaoline and marble dust as a partial replacement to cement in concrete and to recycle the Construction waste materials so that to reduce environmental pollution.
Series of test was carried out on the concrete cylinder to obtain the strength characteristics concrete for potential application in high strength structural Concrete. This chapter discuss on the result that obtained from the testing. The results are such as slump test, compacting factor test, compression test, indirect tensile test and modulus of elasticity for 28days.

I. INTRODUCTION

1.1 GENERAL

In construction Industry, consumption of cement is increasing day by day as well as cost is also increasing so to reduce the consumption of cement, partial replacement with Metakaolin and Marble powder was done in this study. Metakaolin is a calcinied clay and easily available in Gujarat, Maharashtra & Bombay etc. It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain i.e. ceramic material. The particle size of Metakaolin is smaller than cement particles. Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Some of industries used to wash out this marble powder with water in natural streams which cause water pollution and is harmful for our environment. So, it is advisory to use marble dust as partial replacement with cement as it has properties similar to cement and one of good pozzolanas. Similarly use of Metakaolin leads to Green concrete, because during production of Metakaolin concrete there is no emission ofcarbon dioxide Since there is large emission of carbon dioxide in manufacturing of cement and clinker, results in 3-5% increase in greenhouse gasses and global warming.

The growing concern of resource depletion and global pollution has challenged many researchers to seek and develop new materials relying on renewable resources. These include the use of by-products and waste materials for building construction. The high cost of conventional building materials is a major factor affecting construction in India. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used for various purposes in construction industry. This will have double the advantages, reduction in the cost of construction material and also as a means of disposal of wastes. Thus the approach is logical, worthy and attributable. Therefore an attempt has been made in this study to utilize the metakaoline and waste marble powder is used as a partial replacement of cement in the development of low cost concrete. So a study on various strength and durability properties of these materials is carried out. Also suitable measures have to be adopted for attaining the target strength.

1.2 Construction Waste

Environmental Protection Agency (EPA) defines construction and demolition (C&D) waste as waste materials consist of the debris generated during the construction, renovation and demolition of buildings, roads, and bridges. C&D materials often contain materials that include: concrete, asphalt, wood, metals, gypsum, plastics and salvaged building components. It is a challenging task to handle C&D waste because it is bulky, heavy and inert and also mixture of various materials of different characteristics. It is also difficult to choose any suitable disposal method, for example, it cannot be incinerated due to its high density and inertness.

1.3 Metakaoline

Metakaoline is a pozzolanic probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 80ºC.

Figure-1: Metakaoline powder

Marble powder

It is an essential component of igneous and metamorphic rocks. The size varies from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. The crushed marble powder used in the experiments is in a form of white powdered, which replaces fine aggregate from the conventional concrete. The particle size used ranges from 10 to 45µm.

Figure-2: Marble powder waste from construction Industry.

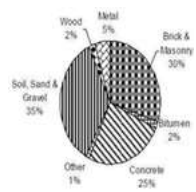


Figure-3: Different constituents of C&D waste.

1.4 Scope of the Work

`The aim of the present study is to use naturally available and low cost metakaoline and marble dust as a partial replacement to cement in concrete and to recycle the Construction waste materials so that to reduce environmental pollution.

1.5 Objectives of the Research

Objectives of the study as follows:

- To study mechanical properties such as compressive strength at the end of 7, 14 and 28 days of curing by partially replacing cement with metakaoline and marble powder under normal curing.
- To reduce environmental Pollution

- To study the properties of fresh pollution by utilizing waste material in concrete.
- To make Eco-friendly concrete
- concrete this is cast by using metakaolin and marble dust
- To study the properties of fresh concrete this is cast by using metakaoline and marble dust.

II. LITERATURE REVIEW

Abdullah Anwar et.al (2014) : In this paper the authors represented that Marble Dust Powder has replaced the (OPC&PPC) cement of 0%, 5%, 10%, 15% 20%, & 25% by weight & M-20 grade concrete was used. Concrete is M30. mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyze the behavior of concrete while replacing the Marble Dust Powder with Different proportions in concrete. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of cement with marble dust powder is about 10% for (PPC) and (OPC). This will post less on the production of carbon dioxide and solving the environmental pollution by cement production there by enhances the urban surroundings.

Sanjay N. Patil et,al (2014) : The paper deals with the use of Metakaolin which is having good pozzolanic activity and is a good material for the production of high strength concrete. Use of MK is getting popularity because of its positive effect on various properties of concrete. Literature Review shows that optimal performance is achieved by replacing 7% to 15% of the cement with Metakaolin and when use of MK is less than 10% , then the benefits are not fully realized so at least 10% Metakaolin should be used. Values of compressive strength of concrete with Metakaolin after 28 days can be higher by 20%. Dosage of 15% of Metakaolin causes decrease of workability. So increasing amount of perceptual proportion of Metakaolin in concrete mix seems to require higher dosage of super plasticizer to ensure longer period of workability.

J.M. Khatib et.al(2012) : In the paper author studied the compressive strength, density and ultrasonic pulse velocity of mortar containing high volume of Metakaolin (MK) as partial substitution of cement. In this paper up to 50% of MK was used to replace cement in increment of 10. After De-molding, specimens were cured in water at 20°C for a total period of 28 days. The density seems to reduce with the increase of MK content especially at MK content above 30%.The strength increases as the MK content increases up to about 40% MK with a maximum strength occurring at 20% where the strength is 47% higher. At 50% the strength start reducing, 10% and the 30% MK mixes exhibit an increase in strength of around 37%.

Prof. P.A. Shirule et.al (2012) : The paper described the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. The Compressive strength of Cubes & Split Tensile strength of Cylinders are increased with addition of waste marble powder up to 10% replaced by weight and it was also observed that 10% replacement gave optimumpercentage of strength

B.B.Sabir et.al (2001) : The paper described the partial replacement of cement with the Metakaolin in concrete and mortar, which causes great improvement in the pore structure and hence resistance of concrete to harmful solutions. The paper also demonstrated clearly that MK is very effective pozzolanas and result enhanced early strength with no detriment to, and some improvement in the long term strength. Mortar and concrete were observed as great improvement in resistance to the transportation of water and diffusion ions which lead to degradation of matrix.

A. ManjuPawar et.al (2014): A Study has been conducted on Periodic Research, The Significance of Partial replacement of Cement with Waste Marble Powder. They found that the effect of using marble powder as constituents of fines in mortar or concrete by partially reducing quantities of cement has been studied in terms of the relative compressive, tensile as well as flexural strengths. Partial replacement of cement by varying percentage of marble powder reveals that increased waste marble powder (WMP) ratio result in increased strengths of the mortar and concrete .Leaving the waste materials to the environment directly can cause environmental problem. Hence the result, The Compressive strength of Concrete are increased with addition of waste marble Powder up to12.5 % replace by weight of cement and further any addition of WMP the compressive strength decreases. The Tensile strength of Concrete are increased with addition of waste marble powder up to 12.5 % replace by weight of cement and further any addition of WMP the Tensile strength decreases. Thus they found out the optimum percentage for replacement of MDP with cement and it is almost 12.5 % cement for both compressive & tensile strength.

III. TESTS ON MATERIALS

3.1. Materials

3.1.1. Cement: cement is a binding material invented by Joseph Aspdin in 1824. It is manufactured from calcareous materials, such as limestone or chalk, and argillaceous material such as shale and c lay.

3.1.2. Coarse Aggregate: If the size of aggregate is bigger than 4. 75 mm, then the aggregate is considered as coarse aggre gate.

Eg: Stone, ballast, gravel, brick ballast.

3.1.3. Fine Aggregate: According to IS 383, most of the aggregate which will pass through 4. 75 mm IS sieve and entirely retained on 75 µ sieve is considered as fine aggregate.

Eg: Sand crushed stone, ash or cinder and surkhi.

3.1.4. Water: water is the main ingredient used to mix all t he contents. Potable water is used as usage of any other water may contain salts and cause decrease in strength of concrete.

3.1.5 Metakaolin

Metakaoline is a pozzolanic probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC.

Figure 3.1: Metakaoline powder

3.1.5 Marble dust powder: It is an essential component of igneous and metamorphic rocks. The size varies from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. The crushed marble powder used in the experiments is in a form of white powdered marble flour, which replaces fine aggregate from the conventional concrete. The particle sizeused ranges from 10 to 45µm.

One of the major wastes produced in the stone industry during cutting, shaping, and polishing of marbles is the MDP. During this process, about 20-25% of the process marble is turn into the powder form. India being the third (about 10%) top most exporter of marble in the world, every year million tons of marble waste form processing plants are released. Due to the availability of large quantity of waste produced in the marble factory, this project has been planned and preceded.

Figure 3.2: marble dust powder

3.2 Tests on Cement

3.2.1 Specific Gravity of Cement

Specific gravity of the cement is calculated by using density bottle method. Cement specific gravity: 3.12

The following is the procedure to find specific gravity of cement.

Aim: To determine the specific gravity of cement

Required Materials & Apparatus:

- Ordinary Portland Cement
- Kerosene
- Specific Gravity Bottle (100 ml)
- Weighing balance with 0.1 gm accurate

Procedure:

1. The Flask should be free from the moisture that means it should be fully dry. Weigh the empty flask(W1)
2. Fill the bottle up to half of the flask (about 50gm) with cement and weigh with its stopper (W2)
3. Add Kerosene to the cement mix well to remove the air bubbles in it. Weigh the flask with cement and kerosene (W3)
4. Empty the flask and fill the bottle with kerosene up to the top and weigh the flask (W4)

3.2.2 Fineness test on cement:

The following procedure is used to find Fineness test on cement.

Aim: To determine the fineness of the given sample of cement by sieving.

Apparatus: IS-90 micron sieve conforming to IS: 460-1965, standard balance, weights, and brush.

Fig- 3.3 Sieve used for find fineness of cement.

Procedure:

1. Weigh exactly 100 g of cement and place it on a standard 90 micron IS sieve.
2. Make the cement sample free from air-set lumps with fingers.
3. Continuously sieve the sample giving round and vertical motion for a period of 15 mins.
4. Weigh the residue left on the sieve. As per IS code the percentage residue should not exceed 10%.

3.2.1 Standard consistency test

The standard consistency trial of cement is characterized as the consistency which allows vicat's plunger of distance across 10mm and 50mm length to penetrate to a profundity of 33 to 35mm from the highest point of the form. The fundamental point is to discover the amount of water content required to deliver a concrete glue of standard consistency according to the IS: 4031 (Part 4) – 1988.

Standard consistency of bond: 32%

Aim: To determine the quantity of water required for produce a standard consistency of cement paste.

Apparatus: Vicat's apparatus (conforming to IS: 5513 – 1976) with plunger (10 mm in diameter) Balance, Gauging trowel

Fig 3.4-Vicat's Apparatus used for finding standard Consistency and initial and final Setting Times of Cement

Procedure:

1. Take 300g of cement and make a paste of cement with a weighed quantity of potable or distilled water starting with 26% water of cement.
2. Take care that the time of gauging is not less than 3 minutes, not more than 5 minutes and the gauging shall be completed before setting occurs.
3. The time is taken at the time of adding the water to the dry cement until commencing to

fill the mould.

4. Fill the vicat mould with this paste, where the mould upon a non-porous plate.

5. After completely filling the mould, trim off the surface of the paste, making it in level with the top of the mould. The mould may slightly be shaken to expel the air.

6. Place the check block with the mould, collectively with the non-porous resting plate, beneath the rod bearing the plunger (10mm diameter), decrease the plunger lightly to touch the floor of the check block and quickly launch, permitting it to penetrate into the paste.

7. This operation shall be executed right away after filling the mould.

8. Prepare trial pastes with varying percentages of water and take a look at as defined above till the quantity of water necessary for making the same old consistency as defined above is acquired.

9. Express the amount of water as a percentage by weight of the dry cement.

IV. EXPERIMENTAL METHODOLOGY

Tests on Fresh Concrete 4.1 Workability tests

4.1.1 Slump test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete.

The apparatus for conducting the slump test ess entially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions bottom diameter 20 cm, top diameter 10 cm, height 30cm. The thickness of metal sheet for the mould should not be thinner than 1. 6 mm. the internal surfa ce of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.

The mould is then filled in four layers, each approximately1/4 of the height of the mould. Each layer is tamped 25 t imes by the tamping rod taking care to distribute the strokes evenly over the cross section. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod. The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside. This subsidence is referred as SLUMP of concrete.

The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured and is taken as the slump of concrete. ASTM measures the center of the slumped concrete as the difference in height.

If the concrete slumps evenly, it is called t rue slump. I f one half of the cone slides down, it is called shear slump. IS 456 - 2000 suggests that in the very low category of workability where strict control is necessary, measurement of workabilit y by determination of compaction factor will be more appropriate than slump.

Fig. 4. 1. Apparatus to determine the workability of concrete (slump test)

4.1.2. Compaction factor test

The compaction factor test is designed primarily for use in t he laboratory. It is more precise and sensitive than the slump test and is mostly useful for very low workability concrete mixes.

Principle: To determine the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. Compaction factor is the ratio of the density actually achieved in the test to densit y of same concrete fully compacted.

The apparatus consists of upper hopper, lower hopper and cylinder. Upper and lower hoppers having, top internal diameter 25. 4 cm, bottom internal diameter 12. 7 cm, internal height 27. 9 cm. dimensions of cylinder are internal diameter 15. 2 cm, internal height 30. 5 cm. the sample of concrete to be tested is placed in the upper hopper up to the brim. The t rap door is opened so that the concrete falls in to the lower hopper. Then the t rap door of the lower hopper is opened so that the concrete falls in to t he cylinder. The excess concrete remaining above the top level of the cylinder is then cutoff and is the cylinder with concrete is weighed. It is considered as the Weight of Partially Compacted Concrete. The cylinder is emptied and then refilled with the same sample in 5 layers each layer is given 25 blows with a tamping rod for the sake of fully compaction. It is taken as the Weight of Fully Compacted Concrete.

Compaction Factor = weight of partially compacted concrete /weight of fully compacted concrete.

Fig. 4. 2 Apparatus for compaction factor test

4.2 Tests on Hardened Concrete

4.2.1. Compression Test

Compression test is the most common test conducted on hardened concrete because most of t he desirable characteristic properties are qualitatively related to it s compressive strength. The compression test is carried out on specimens cubical or cylindrical in shape. The cube specimen is of the size 150 × 150 × 150 mm. The test is conducted on Universal Testing Machine.

The specimens are taken out from t he water tank and kept aside for sometime such that the specimens get dried up. The specimens need to get the measurements before the test ing. The platens of the testing machine were cleaned with a clean rag. Clean the surface of the specimen and place the specimen in t he test ing machine. The platen was lowered until the uniform bearing was obtained. The force was applied and increased continuously at a rate equivalent to 20MPa compressive stress per minute until the specimen failed. Record the maximum force from the test ing machine.

Fig. 4. 3 Setup for Compression Test

4.2.2 Split Tensile Strength of concrete

This test method consists of applying a diametric compressive force along the length of a cylindrical concrete specimen at a rate that is within a prescribed range until failure occurs. This loading induces tensile stresses on the plane containing the applied load and relatively high compressive stresses in the area immediately around the applied load. Tensile failure occurs rather than compressive failure because the areas of load application are in a state of t r iaxial compression, thereby allowing them to withstand much higher compressive stresses t han would be indicated by a uniaxial compressive strength test result. The s ize of the specimen will be 150 mm diameter and 300 mm long.

AIM: To determine of the splitting tensile strength of cylindrical concrete specimens.

Apparatus:

Testing Machine – The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 5.5. The permissible error shall be not more than ± 2 percent of the maximum load.

Cylinders –The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982. Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc.

Fig. 4. 4 Setup for split tensile strength test

Procedure:

1. Sampling of materials – Samples of aggregates for each batch of concrete shall be of the preferred grading with an air-dried circumstance. The cement samples, on arrival on the laboratory, shall be very well combined dry via hand or in a suitable mixer, and make sure with greatest feasible blending and uniformity in the material.
2. Proportioning – The proportions of the materials, together with water, in concrete mixes used for figuring out the suitability of the substances to be had, shall be comparable in all respects to the ones to be employed within the work.
3. Weighing – The quantities of cement, every size of aggregate, and water for every batch will be decided through weight, to an accuracy of 0.1 percentage of the whole weight of thebatch.
4. Blending Concrete – The concrete shall be combined by way of hand, or preferably, in a laboratory batch mixer to avoid loss of water or other materials. Every batch of concrete shall be of this kind of size as to go away about 10 percentage extra after moulding the favored wide variety of check specimens.
5. Mould – The cylindrical mould will be of 150 mm diameter and 300 mm top conforming to IS: 10086-1982.
6. Compacting – The test specimens shall be made as quickly as plausible after blending, and in this kind of way as to produce complete compaction of the concrete with neither segregation nor excessive laitance.
7. Curing – The take a look at specimens will be stored in a place, loose from vibration, in moist air of as a minimum ninety percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the drycomponents.
8. Placing the Specimen within the trying out system – The bearing surfaces of the assisting and loading rollers shall be wiped easy, and any unfastened sand or different cloth removed from the surfaces of the specimen in which they may be to make touch with the rollers.
9. Bearings strips of nominal (1/8 in i.e. 3.175mm) thick plywood, freed from imperfections, approximately (25mm) extensive, and of length identical to or barely longer than that of the specimen ought to be furnished for each specimen.
10. The bearing strips are placed between the specimens and each higher and decrease bearing blocks of the checking out system or among the specimen and the supplemental bars or plates.
11. Draw diametric lines an each cease of the specimen the usage of a suitable device on the way to make sure that they are within the identical axial aircraft. Centre one of the plywood strips along the centre of the lower bearing block.
12. Region the specimen on the plywood strip and align so that the traces marked at the ends of the specimen are vertical and targeted over the plywood strip.
13. Place a second plywood strip lengthwise at the cylinder, focused at the strains marked on the ends of the cylinder. Apply the burden constantly and without surprise, at a regular fee inside, the variety of 689 to 1380 Kpa/ min splitting tensile pressure till failure of the

specimen.

14. Document the most carried out load indicated with the aid of the trying out gadget at failure.

V. RESULTS AND DISCUSSIONS

5.1 Introduction

Series of test was carried out on the concrete cylinder to obtain the strength characteristics concrete for potential application in high strength structural Concrete. This chapter discuss on the result that obtained from the testing. The results are such as slump test, compacting factor test, compression test, indirect tensile test and modulus of e last icit y.

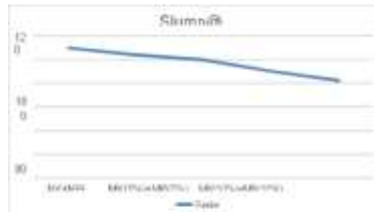
5.2 Slump Test Result and Analysis

The slump test indicates a decreasing t rend of workability when the percentage of metakaolin and marble dust increased. Table shows the average slump recorded during the test. Figure 5. 1 below shows a graphical repres entation of slump height. According to the result, the highest slump obtained was 110 mm and the lowest slump was 82 mm. the average slum for each batch of mix was 96 mm. therefore, target slump had been achieved, where the range is from 50 mm to 120 mm. The workability was good and can be sat isfactorily handle for 0% metakaolin and marble dust to 20% . The slump from 0% metakaolin and marble dust to 20% were considered moderate due to the drop in the range of 5 mm to 9 mm.

Figure 5. 1 : Slump results at MK+ MP 0%, MK+ MP 5%, MK+ MP 10%, , MK+MP 15%, MK+ MP 20%

Table 5. 1 slump values

	MK + MP 0%	MK + MP 5%	MK + MP 10%	MK + MP 15%	MK + MP 20%
Slump @ 0Min	110 mm	104 mm	100 mm	90 mm	82 mm
Slump @ 30Min	98 mm	98 mm	94 mm	88 mm	75 mm



Graph 5. 1 : slump@ 0 min

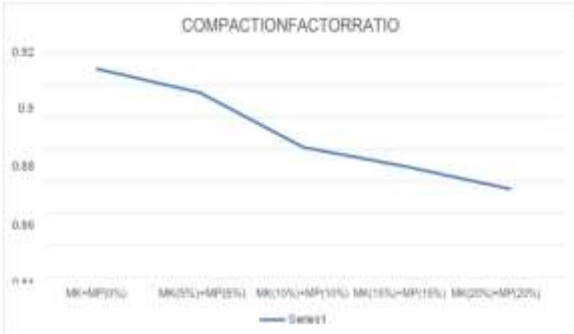
5.1 Compacting Factor Test Result and Analysis

The compacting factor indicates a moderate decreasing t rend of workability when the Percentage of mk and mp increased. Table 5. 2 below show the compacting factor ratio recorded during the test. Figure 5. 2 below sh ows a graphical representation of compacting factor ratio.

Table 5. 2: The Compacting Factor Ratio for Each Of Mix Concrete.

METAKAOLIN AND MARBLE POWDER	0%	5%	10%	15%	20%
Compaction factor	0. 91	0. 895	0. 861	0. 849	0. 835

Figure 5. 2 shown that the compacting factor rat io is decreasing as the percentage of metakaolin and marble powder increased. The result is very similar to the result of slump test. The highest compacting factor ratio is 0. 91 and the lowest is 0. 835. The average of compacting factor ratio for 0% mk and mp to 20% . is 0. 87. There is no problem in handle and compact the fresh concrete in these batches. From the result obtained, we can say that the workability is getting lower due to the increasing of metakaolin and marble powder used.



Graph 5. 2 : Compaction factor ratio

5.1 4 COMPRESSIVE STRENGTH RESULTS AND ANALYSIS

After the curing period the specimen is taken out for the test.The test is carried out on 150x150x150 mm size cubes, as per IS: 516-1959. A 1000KN capacity Compression Testing Machine (CTM) is used to conduct the test. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 Kg/Cm2/min and the failure load in KN is observed from the load indicator of the CTM and the failure load in KN is observed from the load indicator of the CTM.

Compressive strength = Load / Area

Nominal concrete (NC) = Cement + Sand + CA

Compressive strength of metakaolin and marble dust replaced concrete Following are the mixes considered for the study

- 5% Metakaolin + 5% Marble powder + 90% Cement
- 10% Metakaolin + 10% Marble powder + 80% cement
- 15% Metakaolin + 15% Marble powder + 70% cement
- 20% Metakaolin + 20% Marble powder + 60% cement
- Compressive strength of cubes of size 15x15x15cm is tested after 7,14,28 days Table 5.3 : Compressive strength of concrete cubes for 7,14,28 days

S NO	No. of Days	Conventional concrete	MK(5%)+ MP(5%)	MK(10%)+ MP(10%)	MK(15%)+ MP(15%)	MK(20%)+ MP(20%)
1	7	21. 26	22. 63	25. 83	23. 31	19. 27
2	14	30. 89	32. 08	37. 16	32. 74	26.32
3	28	39. 67	41. 34	43. 28	38. 52	31. 12

Fig 5. 2 compressive failure

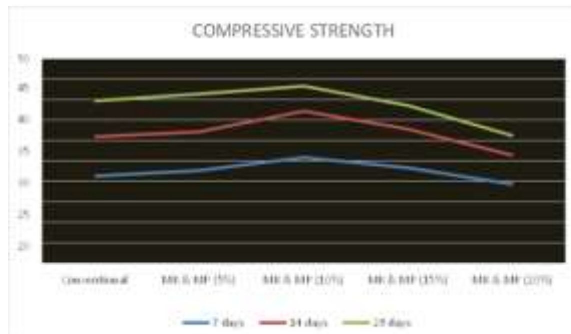


Figure 5.3 : Graph the concrete replaced with Metakaoline and Marble powder 10%+10% has given more strength

Result: It is seen that from the Graph that the concrete replaced with Metakaoline and Marble powder at 10% + 10 % has given Maximum strength which is 41.28 KN/M2

VI. CONCLUSION AND FUTURE SCOPE

6.1 GENERAL

Partial replacement of Metakaolin and Marble powder shows very positive results on compressive strength of concrete at early as well as on later stage. It is very effective in reducing the bleeding and segregation from fresh concrete. The higher percentage replacement (15% and above) reduce the workability and makes difficult to work with concrete which results poor productivity at site. Finer grain size of Metakaolin and Marble powder produces dense and compact concrete which is one of the basic requirements of a good concrete

6.2 CONCLUSIONS

The present experimental investigation was aimed to design a high grade concrete with partial replacement of Metakaolin and Marble powder to cement analysing the same on various parameters to obtain replacement percentage of metakaolin in production of concrete. Some of the broad conclusions

The following conclusions may be drawn based on the experimentations conducted on the behavior of concrete with partial replacement of cement by Metakaolin and Marble powder The addition of Metakaolin along with cement has increased the compressive strength of the concrete when compared to the conventional concrete.

- From the Test results we find that metakaoline and marble powder can be use for partial replacement in concrete.
- The compressive strength of concrete is more at 10%+10% replacement of metakaoline and marble powder. Has give maximum strength is 43.28 KN/M2
- The Split tensile strength of concrete Cylinder strength of concrete is more at 10%+10% replacement of metakaoline and marble powder. Has give maximum strength is 4.73 KN/M2
- Flexural strength of concrete replaced with Metakaoline and Marble powder 10% + 10
- % has given Maximum strength which is 4.23 KN/M2
- Workability of concrete is also reducing due o increase in percentage of metakaoline and marble powder.
- Strength and durability of concrete is increase
- Eco-friendly by reducing of CO2

By replacing the cement and sand with Metakaolin and Marble powder the reduction in the consumption of cement can be achieved. By reducing the consumption of cement. the ecology of the earth can be improved enormously and the air pollution due to the production of cement can also be reduced. Comparative analysis for beam is done.

6.3 FUTURE SCOPE

The present experimental investigation was confined to the strength evaluation of concrete using Metakaolin and Marble powder combination with the cement. The invistigationcan be extended in future to incorporate some of the following aspects which have not been covered in the present study :

1. Tests for mix design of higher grade of concrete can be considered
2. Permeability tests of the above combinations may be undertaken
3. Metakaolin replacement accelerates the rate of gain of strength in concrete and is predominant at early age

REFERENCES

1. Abdullah Anwar et.al (2014): Study of Compressive Strength of Concrete by Partial Replacement of Cement with Marble Dust Powder. Ird Indian ISSN (Print
2. Sanjay N. Patil et.al (2014): Metakaolin-Pozzolanic Material For Cement in High Strength Concrete . (IOSR-JMCE) ISSN: 2278- 1684, PP: 46-4.
3. J.M. Khatib et.al (2012): High Volume Metakaolin as Cement Replacement in Mortar. World Journal of Chemistry, ISSN 1817- 3128, © IDOSI Publications, DOI: 10.5829/idosi.wjc.2012.7.1.251.
4. Prof. P.A. Shirule et.al (2012) Partial Replacement of Cement with Marble Dust Powder. International Journal of Advanced Engineering Research and Studies E- ISSN2249– 8974 IJAERS/Vol. I/ Issue III/April-June, 2012/175-177.
5. B.B.Sabir et.al (2001)Metakaolin and

calcined clays as pozzolanas for concrete:a review.Cement & concrete composites 23(2001) 441-454. [6] Hassan A. Mohamadien et.al (2012) The Effect of marble powder and silica fume as partial replacement for cement on mortar. ISSN 0976 – 4399, PP 418-428.

6. V. M. Sounthararajan and A. Sivakumar (2013) Effect of the lime content in marble powder for producing high strength concrete .ISSN 1819-6608.PP 260-264. [8] Vaidevi C (2013) Study on marble dust as partial replacement of cement in concrete
.ISSN 2319 – 7757.PP 14-16.
7. Vaidevi C (2013) Studyon marble dust as partial replacement of cement in concrete .ISSN 2319 – 7757.PP 14-16.
8. Nutan Patel et.al (2013) Marble Waste: opportunities for development of low cost concrete.ISSN No 2277 – 8160.PP 94-96.
9. Noha M. Soliman (2013) Effect of using Marble Powder in Concrete Mixes on the Behavior and Strength of R.C. Slabs.ISSN 2277 – 4106, PP 1863-1870.
10. Er. Tanpreet Singh and Er. Anil Kumar Nanda (2013) Influence of marble powder on mechanical properties of mortar and concrete mix. PP 193-203.
11. Animesh Mishra et.al (2013) Green Cement For Sustainable Concrete Using Marble Dust. ISSN: 0974- 4290, PP 616-622.
12. D.B. Desai et.al(2013) Green concrete need of environment.ISSN 2319-5924,PP 134-137.